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which necessarily caused both a diminution of the light and also a diminished sensitiveness of the collodion film.

The rapidity with which the above pictures were taken may be better understood by comparing them with those of terrestrial objects under similar circumstances. According to Herschel\*—

“The actual illumination of the lunar surface is not much superior to that of weathered sandstone rock in full sunshine. I have frequently compared the moon setting behind the grey perpendicular façade of the Table Mountain, illuminated by the sun just risen in the opposite quarter of the horizon, when it has been scarcely distinguishable in brightness from the rock in contact with it. The sun and moon being nearly at equal altitudes, and the atmosphere perfectly free from cloud or vapour, its effect is alike on both lumenaries.”

Thus by comparing the Liverpool object-glass as to power with our ordinary camera lens, its focal length being nearly 19 times the aperture, and the moon’s image being copied by its means in 4 seconds, we find that it is equivalent to copying sandstone illuminated by the sun in 4 seconds with a lens  $4\frac{1}{2}$  inches focus and a little less than  $\frac{1}{4}$  inch diaphragm; or with a compound lens having an aperture of one inch, and the same focal length, in a quarter of a second.

## II. “Researches on the Reproductive Organs of the Annelids.”

By THOMAS WILLIAMS, M.D., F.L.S., Physician to the Swansea Infirmary. Communicated by THOMAS BELL, Esq., F.R.S., P.L.S. &c. Received December 30, 1856.

(Abstract.)

In this paper the author seeks to establish the following general proposition, viz. that there prevails throughout the Actiniadæ, Echinodermata, Rotifera and Annelida, a special organ, which, under different phases, subserves different functions, which is essentially *identifiable* under every modification, reducible to the same type, and which constitutes the *root* of the Reproductive system in these families. To this special organ he proposes to apply the provisional

\* Herschel’s Outlines of Astronomy, page 249.

name of the "segmental organ\*." In the chambers which are enclosed by the vertical dissepiments dividing the body of *Actinia*, convoluted tubular cords are contained which support the generative structures. It has not yet been proved whether the internal ends of these tubules open directly into the perivisceral chamber. These cords and their appended structures in the *Actiniadæ*, constitute the *type* of a system of organs the prevalence of which throughout the Echinodermata, Rotifera and Annelida can, he believes, be clearly and satisfactorily proved. In the present memoir, however, the author proposes to confine his demonstrations to the anatomical varieties which the segmental organ presents in the class *Annelida*, contenting himself with merely in a passing manner pointing out the fact that the several variations of form, structure and number which this organ exhibits in the several genera of this class, are *represented* by similar variations in the different genera, especially of the class Echinodermata. He hoped to show that under very numerous apparent varieties, the essential unity of the segmental organ within the indicated limits can be convincingly established.

Upon this organ, under different circumstances, there devolve one or two or even more functions. Sometimes it is used as a simple *discharge tube*, conveying externally in a direct manner the fluid of the general cavity of the body. This variety is exemplified in the segmental organs which are distributed, in the genera *Lumbricus* and *Nais*, throughout all that part of the body which is situated posterior to the Reproductive band. In this latter region two or more of these organs are so modified as to become the basis whereon is developed the generative structures.

Here the author enters upon a minute account (illustrated by figures) of the history of this organ in *Lumbricus* and *Nais*, showing the changes of outward form which it undergoes in several species of these genera.

He points out in this place that the segmental organ, as it occurs in *Lumbricus* and *Nais*, is paralleled by the so-called water-vascular system of the Rotifera: as in the former so in the latter, the ciliated tubes communicate openly with the general cavity; in both, the cur-

\* While he is convinced that the identity of this organ might readily be traced throughout other families of the lower Invertebrata, he will not permit himself at present to indulge in any wider generalization than that stated in the text.

rent raised by the cilia travels from within outwards; and he contends that the reproductive structures are ingrafted upon, or developed from one, two or more of the ciliated tubes in the Rotifera, as from the segmental organs of *Lumbricus* and *Nais*.

*Arenicola* and *Terebella* form a group in which the segmental organ deviates in a remarkable apparent manner from that of *Lumbricus* and *Nais*. It forms a series of elongated sacculi, which are attached to the ventral wall of the general cavity on either side of the median line. Each sacculus, although single at its distal end, is divided at its attached end into two tubular limbs, one of which communicates directly with the exterior, while the other opens immediately into the general cavity of the body. Through the latter limb the *ova* and *sperm-cells* are introduced into the perivisceral chamber, while in the reverse direction the *fluid* of this chamber is discharged externally. The author has never been able to discover how the germ- and sperm-cells (respectively in the female and male) escape out of the general cavity. But he trusts that he has given a new and satisfactory demonstration of the mode in which they *enter* that cavity. The genera *Arenicola* and *Terebella* comprehend the *only Annelids* in which the germ-elements in the female, and the sperm-cells in the male, are ushered into, and are required to sojourn for a season in the fluid of the general cavity of the body.

He indicates in this place that the segmental organ of the *Sipunculidae* (amongst the Echinoderms) corresponds both in its structure and relations to that of *Arenicola* and *Terebella*, with this difference only, that in the latter a special and *peculiar development* of the blood-vascular system occurs around and in the vicinity of the segmental organ, whereas in the *Sipunculidae* this system scarcely exists and never receives any enlargement. The segmental organs in the genus *Synapta* stand in an intermediate position between those of *Holothuria* and those of *Sipunculus*. In *Synapta* one or more organs remain in the condition of simple 'discharge tubes,' while others become developed into the Reproductive structures.

The segmental organs of the *Hirudinaceæ* are next described. The author adheres almost in every detail to the results published by him in 1851 in the *Transactions of the British Association*, with reference to the reproductive system of this family of *Annelids*. In the present memoir he records the results of new and carefully conducted dissections, which prove that in the Common Leech, the Sea-leech,

and probably in the genus *Clepsina*, there is situated an organ on either side of the ventral median line, which is repeated *in every ring of the body*, and which in this family is the true ovigerous apparatus, the testes constituting a separate and more medianly disposed series of glandular bodies, whose homologies he has not yet satisfactorily determined.

The so-called "respiratory sacculus" of Dugès he now looks upon as the process of the ovario-segmental organ, by which a communication is established between the latter and the general cavity of the body, and by which the fluid of this chamber escapes externally. All the Hirudinaceæ are androgynous.

Under the Nereid group is included in this memoir, the genera *Nereis*, *Aricia*, *Phyllodoce*, *Nephthys*, *Syllis* and *Nerine*. The segmental organ in these families is specially described and figured. In all, the sexes are seated on separate individuals. In no single instance is the general cavity rendered subservient to the incubatory process. In all, the general circumference of the organ is lobulated and irregular, entering the hollow bases of the cirrhi and blended most intimately with the blood-vascular system.

*Glycera* and *Cirrhatulus* the author classes together, on account partly of the similarity of form and structure of the segmental organ, but especially because in both the *blood-vascular system is completely and entirely wanting*, its absence being compensated by the existence of a second order of pigment-carrying corpuscles in the cavitary fluid. These genera are unisexual, and at no time are the germ- and sperm-elements introduced into the perivisceral chamber.

In this and the preceding groups the author has not succeeded in discovering the mode in which the segmental organ opens into the general cavity; but from the fact that it has a looped arrangement, supported on two tubular limbs, he is quite convinced that an opening into this cavity, for the purpose of giving direct outlet to its contents, does really exist. This conclusion is fortified by the analogy of the form under which the organ exists, in the Nereid group in general.

The *Nemertine Annelids* are then examined. The author recalls the results of his researches as published in his 'Report' on the Annelids in 1851. His renewed investigations have confirmed the statements which he then put forth. He still contends that what M. Quatrefages has described in these worms as the *ovary* is a great

alimentary cæcum, and that the Reproductive system consists in a double series of segmental organs, one on either side of this great cæcum and the ventral median line ; that in this family the sexes are seated on separate individuals ; that the reproductive elements at no time find their way into the general cavity ; that in fact these Annelids, anomalous only in the disposition of their alimentary system, conform, as regards the type and mode of repetition of segmental organs, to the standard offered by the great Nereid group.

*Chloræma Dujardinii*, especially the female, presents an extremely favourable opportunity of observing the *looped arrangement* of the segmental organ, and of proving the fact, so constantly seen in the other families of Annelids, viz. that *one limb* of the loop is the true ovary, or the primary seat of the ovo-genesis ; that the ovules travel round the curve of the loop ; that they acquire a considerably developed size at the other limb, just before they escape externally. In *Chloræma* the vitelline body of the ova is almost ink-black. The entire extent of the segmental organ is thus rendered perfectly and easily traceable amid the surrounding transparent structures. In this genus it does not at present appear that either limb of the loop opens into the general cavity. This type prevails, as far as he knows at present, throughout the Nereid group ; in other words, in these Annelids the function of a *discharge tube* does not appear to be thrown upon the segmental organ under any circumstances ; hence the limited dimensions of the general cavity and the highly developed character of the blood-vascular apparatus.

The group lastly examined, is that of the Aphroditaceæ. On the reproductive organs of this large, numerous and interesting family, no single observation is contained in any work on comparative anatomy that the author is acquainted with. He enters upon a detailed account of his own researches. They have ended in what he would fain believe to be a complete solution of the difficulties in which the history of the Reproductive or segmental system of this family has been hitherto shrouded. This family, without exception, is unisexual. The segmental organs constitute a complete and regularly branched series, situated, as in all other Annelids, on either side of the ventral median line. They embrace, like a gauze-work, the diverticula of the alimentary system, with which they correspond in number. They fall under the general designation of the "segmental

organ," in the feature of their having *two limbs*, being therefore looped, although only rudimentarily. The author then proceeds to give an account of his studies into the history of this organ amongst the grotesque and highly varied species of the genus *Polynoë*. They have rendered it certain that throughout the family of the Aphroditaceæ there obtains but *one type of segmental organ*, and *that upon it always are ingrafted the generative structures*.

At this stage the attempt is made to show that the segmental organs of the Echinidæ, Asteriadæ and Holothuriadæ conform, structurally and functionally, in the most remarkably intimate manner with the typical standard exhibited by this organ in the Aphroditaceæ. But between these Echinoderm and Annelidan families the author attempts to indicate other zoological affinities. He shows, that, according to his researches amongst the Aphroditaceæ, there is no trace whatever to be discovered of a blood-vascular system. In this respect they correspond with the Echinidan and Asteridan families. He shows that in the Aphroditaceæ the general cavity is never, under any circumstances, used as an incubatory chamber. In this point of their generative history the Echinidæ and Asteriadæ exactly agree with the Aphroditaceæ.

The author regrets, that, in consequence of the difficulty of obtaining specimens, he is obliged to defer to a second memoir many special points of anatomical structure and physiological relations, the determination of which he still feels to be necessary to the complete history of the segmental organ in the Annulose and Radiated classes.

The paper is illustrated by numerous drawings.

III. "Addition to a Memoir on the Determination of Unknown Functions that are evolved under Definite Integrals." By J. GOMES DE SOUZA, Esq. Communicated by Dr. SHARPEY, Sec. R.S. Received November 1, 1856.

In his previous communication (Proceedings, June 12, 1856) the author developed  $\varphi x$  in terms of the function  $A e^{m_r x}$ . In the present communication he develops in a more general way, using terms of the form  $A_r \int_r^\delta e^{x\omega} \varpi(\omega_1 m_r) d\omega$ , the function of  $\varpi$  being assumed at pleasure.